NOG gene

noggin

Normal Function

The *NOG* gene provides instructions for making a protein called noggin. This protein is involved in the development of many body tissues, including nerve tissue, muscles, and bones. Noggin's role in bone development makes it important for proper joint formation.

Noggin interacts with members of a group of proteins called bone morphogenetic proteins (BMPs). These proteins help control the development of bone and other tissues. In order to begin these developmental processes, BMPs attach (bind) to other proteins called receptors, and this binding stimulates specific cellular processes. The noggin protein regulates the activity of certain BMPs by attaching to them and blocking them from binding to the receptor, which leads to a decrease in BMP signaling.

Health Conditions Related to Genetic Changes

tarsal-carpal coalition syndrome

Several mutations in the *NOG* gene have been identified in people with a condition called tarsal-carpal coalition syndrome. This condition is characterized by fusion of the individual bones in the wrists (the carpal bones) and in the ankles (the tarsal bones) as well as fusion at the joints between the bones that make up each finger and toe (symphalangism). Symphalangism makes the fingers and toes stiff and difficult to bend.

This condition is caused by mutations in the *NOG* gene that change single protein building blocks (amino acids) in the noggin protein. These mutations alter the structure or stability of noggin, impair the transport of noggin out of the cell, or reduce the protein's ability to bind to BMPs, resulting in a reduction of functional noggin protein. With decreased noggin function, BMPs abnormally stimulate bone formation in joint areas, where there should be no bone, causing the bone fusions seen in people with tarsal-carpal coalition syndrome.

other disorders

Several other bone-related disorders are caused by mutations in the *NOG* gene. These gene mutations change single protein building blocks (amino acids) in the noggin protein.

Proximal symphalangism is characterized by fusion at the joints between the bones in the fingers and toes, particularly at the joint at the base of the digit. Other signs and

symptoms include abnormally short middle fingers, webbed toes, and hearing loss that is due to fusion of the bones in the ears (stapes fixation).

Multiple synostoses syndrome 1 is characterized by symphalangism and characteristic facial features, such as a broad nose and thin lips. In addition, affected individuals can have fusion of the bones in the hands, feet, hips, and upper part of the spine (cervical vertebrae). People with this condition can have hearing loss due to stapes fixation.

People with stapes ankylosis with broad thumb and toes (also known as Teunissen-Cremers syndrome) have hearing loss due to stapes fixation, farsightedness, and broad thumbs and big toes. Some affected individuals may have fusion of the cervical vertebrae and characteristic facial features like those seen in multiple synostoses syndrome 1.

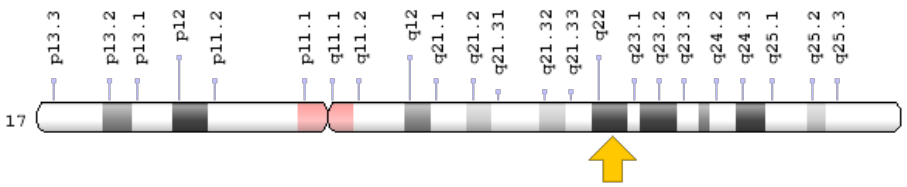
Brachydactyly type B2 is characterized by short fingers and toes, which occurs because the middle bone of the digit or the bone that forms the tip of the digit is abnormally small or absent. In addition, people with this condition can have symphalangism, fusion of the carpal bones, and connection of the skin between two or more fingers or toes (syndactyly).

As in tarsal-carpal coalition syndrome, the *NOG* gene mutations that cause these conditions reduce the amount of functional noggin protein. For reasons that are unknown, the same mutations can cause different disorders in different people. Because of a shared genetic cause and overlapping features, researchers have suggested that these conditions, including tarsal-carpal coalition syndrome, represent a spectrum of related conditions referred to as NOG-related-symphalangism spectrum disorder (NOG-SSD).

Chromosomal Location

Cytogenetic Location: 17q22, which is the long (q) arm of chromosome 17 at position 22

Molecular Location: base pairs 56,593,699 to 56,595,590 on chromosome 17 (Homo sapiens Annotation Release 108, GRCh38.p7) (NCBI)



Credit: Genome Decoration Page/NCBI

Other Names for This Gene

- NOGG_HUMAN
- noggin precursor
- SYM1
- symphalangism 1 (proximal)
- SYNS1

Additional Information & Resources

Educational Resources

- Developmental Biology (sixth edition, 2000): Forming the Joints
  https://www.ncbi.nlm.nih.gov/books/NBK10048/#A3976

Scientific Articles on PubMed

- PubMed
  https://www.ncbi.nlm.nih.gov/pubmed?term=%28%28NOG%5BTIAB%5D%29+OR+%28noggin%5BTIAB%5D%29%29+AND+%28%28Genes%5BMH%5D%29+OR+%28Genetic+Phenomena%5BMH%5D%29%29+AND+english%5Bla%5D+AND+human%5Bmh%5D+AND+%22last+720+days%22%5Bdp%5D

OMIM

- BRACHYDACTYLY, TYPE B2
  http://omim.org/entry/611377
- MULTIPLE SYNOSTOSES SYNDROME 1
  http://omim.org/entry/186500
- NOGGIN, MOUSE, HOMOLOG OF
  http://omim.org/entry/602991
- STAPES ANKYLOSIS WITH BROAD THUMB AND TOES
  http://omim.org/entry/184460
- SYMPHALANGISM, PROXIMAL, 1A
  http://omim.org/entry/185800

Research Resources

- Atlas of Genetics and Cytogenetics in Oncology and Haematology
  http://atlasgeneticsoncology.org/Genes/GC_NOG.html
- ClinVar
  https://www.ncbi.nlm.nih.gov/clinvar?term=NOG%5Bgene%5D

- HGNC Gene Symbol Report
  http://www.genenames.org/cgi-bin/gene_symbol_report?q=data/hgnc_data.php&hgnc_id=7866
- NCBI Gene
  https://www.ncbi.nlm.nih.gov/gene/9241
- UniProt
  http://www.uniprot.org/uniprot/Q13253

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